What Can You Learn from a Cell Phone? Almost Anything!

by Marc Prensky

One and a half billion people, all over the world, are walking around with powerful computers in their pockets and purses. The fact is they often do not realize it, because they call them something else. But today's high-end cell phones have the computing power of a mid-1990s personal computer (PC)—while consuming only one one-hundredth of the energy. Even the simplest, voice-only phones have more complex and powerful chips than the 1969 on-board computer that landed a spaceship on the moon.

In the United States, it is almost universally acknowledged that computers are essential for 21st-century students. To most educators "computer" means a PC, a laptop, or, in some instances, a personal digital assistant (PDA); cell phones, on the other hand, are more often regarded as bothersome distractions to the learning process. However, it is time to begin thinking of our cell phones as computers—even more powerful in some ways than their bigger cousins. Both have microchips and perform logical functions. The main difference is that the phones began with, and still have, small size, radio transmission, and communication as their core features, expanding out toward calculation and other functions. This has happened at precisely the same time as the calculation machines we call computers have expanded into communication and other areas. Clearly the two are headed toward meeting in the middle; when all the miniaturization problems have been solved, the result will be tiny, fully featured devices that we carry around (or perhaps have implanted in our bodies).

For now, most educators still see the computer and the cell phone as very different devices, with the tiny cell phone being a much more personal (and ubiquitous) accoutrement, especially among young people. In the United States, the penetration of student mobile phones is 40% in many junior high schools and 75% in many high schools (NOP World 2005); according to a Student Monitor survey (as cited in Kinzie 2005), penetration is 90% in U.S. colleges. With dropping prices and increasing utility, it is almost a foregone conclusion that not too far into the future, *all* students will have a cell phone, quite possibly built right into their clothing. Ski parkas with built-in cell phones are already on the market. Yet Americans do not fully appreciate the potential of these devices; from a cell phone perspective, we remain PC-centric laggards.

Meanwhile, the cell phone—generally called a mobile phone outside of the United States—has proved so useful elsewhere that there are 1.5 billion around the world, with half a billion new ones sold every year (Stone 2004). The country where the computer was invented, along with its northern neighbor, Canada, are the only places where PCs still outnumber cell phones. In the rest of the world the mobile reigns, with countries often having 5 to 10 times more mobile phones than PCs.

In some countries—including the United Kingdom, Italy, Sweden, and the Czech Republic—cell phone penetration is *greater than* 100%, which means that individuals own and use two or more of these devices (Borghese 2005; Agence France-Presse 2004). Cell phone penetration in Asia continues to climb: Hong Kong and Taiwan have already surpassed 100% according to one prominent survey (IT Facts 2004; Simon 2004), and several years ago, *J@pan Inc* magazine reported that more than 90% of Tokyo high schoolers carried mobile phones (2001). Usage is increasing wildly across the globe, notably where relatively inexpensive cell systems bring service to areas without land lines. In Botswana, roughly one of every four citizens owned a mobile phone by 2002 (Central Intelligence Agency 2005, "People"; "Communications"). Moreover, students in China, the Philippines, and Germany are using their mobile phones to learn English; to study math, health, and spelling; and to access live and archived university lectures, respectively (BBC Press Office 2005; Villafania 2004; Chapman 2003).

Cell phones are not just communications devices sparking new modalities of interaction between people; they are also particularly useful computers that fit in your pocket, are always with you, and are nearly always on. Like all communication and computing devices, cell phones can be used to learn. So rather than fight the trend of kids coming to school carrying their own powerful learning devices—which they have already paid for—why not use the opportunity to their educational advantage?

Designing Cell Phones as Learning Tools

Can cell phones really provide their owners with the knowledge, skills, behaviors, and attitudes that will help them succeed in their schools, their jobs, and their lives? I maintain that the only correct answer to the question of what students can learn with a cell phone is "*anything*, if we educators design it right." There are many different kinds of learning and many processes that people use to learn, but among the most frequent, time-tested, and effective of these are listening, observing, imitating, questioning, reflecting, trying, estimating, predicting, speculating, and practicing. *All* of these learning processes can be supported through cell phones. In addition, cell phones complement the short-burst, casual, multitasking style of today's "Digital Native" learners. Using cell phones as learning devices, whether in or out of school, requires a good deal of rethinking and flexibility on the part of educators. Yet given the opportunity, students will quickly embrace, use, and make the tool their own in various unexpected ways—just as they have been doing with all useful digital technology.

Feature Segmentation

So what and how can our students—including adult trainees—learn from their cell phones?

A useful way to answer this question is to consider the capabilities that phones in use today possess, and to see what each capability brings us. With half a billion cell phones sold each year, the devices are hotbeds of feature innovation—the major features being voice, short messaging service (SMS), graphics, user-controlled operating systems, downloadables, browsers, camera functions (still and video), and geopositioning—with new features such as fingerprint readers, sensors, and voice recognition being added every day. In addition, optional hardware and software accessories are available as both input mechanisms (e.g., thumb keyboards and styli) and optional output systems (e.g., plug-in screens and headphones).

Voice Only

The most basic phones—those with voice capabilities only—are still the most prevalent in the world, although they are fast being replaced and upgraded. They are basically radios that pick up and send signals on certain predetermined frequencies.

Is there anything students can learn on a voice-only phone? Languages, literature, public speaking, writing, storytelling, and history are just a few of the subjects that are highly adaptable to voice-only technology. Of these, language is probably the most obvious. Given the huge demand and market around the world for English lessons and practice, it is the one kind of learning that is already readily available on cell phones. In Japan, you can dial a number on your cell for short English lessons from ALC Press's Pocket Eijiro (McNicol 2004) or Japanese lessons from Enfour's TangoTown. In China, the British Broadcasting Corporation (BBC) and others are providing cell phone English-language training (BBC Press Office 2005). One company, MIG China Ltd. (working with First International Digital), is even subtitling pop songs with their lyrics, highlighting each word as it is sung (First International Digital 2004). Companies such as Ectaco provide language games via mobile phone "flash cards," as well as dictionary and phrase book software to aid in foreign language proficiency. And the Canadian corporation Go Test Go has developed English vocabulary testing software. While many of these sites have quickly moved to the mixed media that the phones in their regions support, much of what they offer can be made available easily on voice-only phones. Creating an interactive voice-only cell phone learning application today requires no more than the simple technology used to direct help desk callers, development kits for which are available for under $500.

Other types of voice-only learning applications exist and are growing in popularity. In Concord, Massachusetts, you can use a cell phone for guided tours of Minute Man National Historical Park, where the "shot heard 'round the world" was fired. As part of Ultralab's eVIVA project, Anglia Polytechnic University (in the United Kingdom) has experimented successfully with using cell phones for exams, with the students' voice prints authenticating that they are the ones being tested (*BBC News* 2003; McGuire, Roberts, and Moss 2004). And it doesn't have to stop there. Have you ever listened to *Car Talk* or *Fresh Air* on NPR, or to the BBC? Remember, cell phones are basically radios. Students don't need anything more than a voice link and a person on the other end worth listening to in order to learn a great deal. Why not offer cell-phone-delivered lectures (really engaging ones) on basic subjects, with cell phone call-ins and multiway discussions?

An immediate advantage of voice-only learning is that we know it works—for millennia it was the only type of learning humans had. While some "Digital Immigrant" adults may have a difficult time with, and even question the value of, non-face-to-face voice communication for learning, virtual relationships are now second nature to students, and often preferred.

Short Text Messages

SMS, only recently introduced in the United States, has been available on cell phones outside the country for several years. This feature has spread like wildfire among young people in Europe and Asia, with literally billions of SMS messages being sent every day around the world. Short text messages, which can be written quickly, even in your pocket (especially with predictive text), offer enormous learning opportunities.

Currently, SMS messages provide timely "learning" reminders and encouragement for people trying to change their behavior (e.g., for someone who wants to quit smoking). SMS is also the technology used for voting on the television show *American Idol*. Marketers use SMS for informational quizzes about subjects of interest to young people, such as movie and television stars. And innovative SMS games, many of which have strong educational potential, are attracting large playing audiences. (For more information on recent developments in SMS technology, see the textually.org weblog.)

In schools, SMS can be used to conduct pop quizzes or spelling or math tests, to poll students' opinions, to make learners aware of current events for class discussion (e.g., with messages from Cable News Network's *Breaking News*), and even to tutor students. Outside of school, test preparation companies such as The Princeton Review, Kaplan, and Go Test Go are already offering cell-phone-delivered test-preparation questions (for the Scholastic Achievement Test and others) at specific user-preferred times. Educators easily could use SMS technology to provide cell phone learners, individually and in competitive or collaborative groups, with data and clues in real time for analysis, diagnosis, and response, whether in a historical, literary, political, scientific, medical, or machine-maintenance context.

Graphic Displays

Just about every cell phone has some kind of graphic display, even if it shows only the signal and battery strength and the name and/or number of a contact. Most new cell phones come with far more graphic power than that—they typically sport bright color screens that can crisply display words, pictures, and animation. Many of these screens have resolutions of 320 × 240 pixels—half the screen size of the standard computer of not too long ago—and higher. They present thousands of colors and even three-dimensional images and holograms.

Such high-resolution screens allow for meaningful amounts of text to be displayed, either paragraph by paragraph or one quickly flashed word at a time, known as RSVP—rapid serial visual presentation— with the user setting (and generally greatly increasing) his or her own reading speed. A service called BuddyBuzz offers content from Reuters and CNet using RSVP. In Asia, novels intended to be read on phone screens are already being written (Web Japan 2004). Why not learning texts?

Better graphic displays also mean that text can be accompanied by pictures and animation (and, of course, sound—it *is* a phone). Many schools are currently using computers and handheld devices for animations in subjects such as anatomy and forensics; Bryan Edwards Publishing is one company that provides PDA-compatible animations to educational institutions. Cell phones can replace these handheld devices, especially given that many of the animations are in Flash, which currently runs on many cell phones and eventually will run on all of them. Macromedia already offers what it calls "Flash Lite" applications, including one for learning sign language. The Chemical Abstracts Service is preparing a database of molecule images that can be accessed via cell phone.

Japanese students have long learned everything from business to cooking through "manga," graphic novels that are now becoming popular in the West as well. At a recent computer show, a Japanese company handed out a manga pamphlet (about its "middleware" software) that could easily be displayed one frame at a time on a cell phone—similar to the so-called "mobile manga" that has recently become a phenomenon in Japan (Raugust 2004). It follows that in many cases, our mobile phones will be able to replace our textbooks, with the limited screen size of the phones being, in fact, a positive constraint that forces publishers to rethink their design and logic for maximum effectiveness, rather than just add pages.

Downloadable Programs

Now that cell phones have memories (or memory card slots) that accept downloaded programs and content, entire new learning worlds have opened up. Cell phone users can access versions of the same kinds of tools and teaching programs available on personal computers, and, given that the phones are communications devices, use the tools for collaboration in new and interesting ways. All manner of applications combining elements of voice, text, graphics, and even specially designed spreadsheets and word processors can be downloaded to phones, with additional content added as needed. Other tools currently available for download include browsers, fax senders, programming languages, and even an application that gives you access to your desktop computer.

Do you need to learn or review a particular subject? Do you want to practice for a professional school entrance exam? Soon you'll just download a program to your cell phone, text your friends, and start studying.

Internet Browsers

Internet browsers are now being built into a growing number of cell phones, especially those that use the faster third-generation protocol (3G). Sites and options designed specifically for Web-enabled cell phones are becoming more and more numerous (Exhibit 1). Having a browser in the cell phone puts a dictionary, thesaurus, and encyclopedia into the hands of every student. It gives them instant access to Google and other text search engines, turning their cell phones into research tools. For example, students studying nature, architecture, art, or design can search for images on the Web that match what they find in life in order to understand their properties, style, and form.

Cameras and Video Clips

Worldwide, 178 million camera phones were sold in 2004 (InfoTrends/CAP Ventures 2005), and in many places such phones are already accepted as the norm. Educationally—once students learn that privacy concerns are as important here as anywhere else—they are a gold mine. In class, cell phones with cameras provide possible tools for scientific data collection, documentation, and visual journalism, allowing students to gather evidence, collect and classify images, and follow progressions over time. Creative cell phone photos can inspire students' creative writing via caption or story contests. Phones can be placed in various (appropriate) places and operated remotely, allowing observations that would be impossible in person. Students can literally see what is going on around the world, including, potentially, learning activities in the classrooms of other countries.

Moreover, the first video cam phones are now hitting the market. They are capable of taking and sending short (typically 10- to 30-second) video clips. This feature extends the phone's learning possibilities even farther, into television journalism (most TV news clips are less than 30 seconds) as well as creative movie-making. A terrific educational use of short video clips would be modeling effective and ineffective behaviors relating to ethics, negotiation, and other subjects.

Global Positioning Systems (GPS)

The initial crude ability of cell phones to "know where they are" quickly became the basis of some very innovative applications, including mobile-phone-based multiplayer search games (more than a dozen are currently in circulation). Now sophisticated GPS satellite receivers that can pinpoint a phone's location to within a few feet are being built into many cell phones (and made available as add-ons for many others).

This feature allows cell phone learning to be location-specific. Students' cell phones can provide them with information about wherever they happen to be—in a city, in the countryside, or on a campus. So-called "augmented reality tours" have been designed (for example, see Papageorgiou et al. 2000), and someday most schools and colleges will use similar programs for orientation. The ability of students to determine their precise position has clear applications in geography, orienteering, archeology, architecture, science, and math, to name only a few subjects. Students can use cell phones with GPS to search for things and places (already known as "geocaching") or to pinpoint environmental dangers, as in the case of Environmental Detectives, a learning game from the Massachusetts Institute of Technology.

Reorienting Research and Practice

In Japan, Masayasu Morita, working with ALC Press, evaluated the use of English language lessons formatted differently for computers and cell phones. He found that 90% of cell phone users were still accessing the lessons after 15 days, compared to only 50% of computer users (2003). Another Japanese company, Cerego, strongly supports using cell phones for learning. Outside of Asia, however, I have found that the number of people learning with cell phones or doing research on cell-phone-based learning is exceedingly small.

Researchers such as Cathleen Norris and Elliot Soloway (2003) in the United States, Jill Attewell and Carol Savill-Smith (2004) in Great Britain, and Giorgio da Bormida and Paul Lefrere (2003) in Europe are experimenting with mobile devices for learning—but they typically use PDAs, not cell phones. The former are often donated by manufacturers eager to find a new market for their devices.

This is not the same as using *cell phones* for learning. There are fewer than 50 million PDAs in the world but more than 1.5 billion cell phones. Of course PDA-based research will be useful, but we will not be on the right track until educators begin thinking of using the computing and communication device *currently in the students' pockets* to support learning.

New Approaches and Emerging Ethics

As usual, students are far ahead of their teachers on this. The first educational use they have found (in large numbers) for their cell phones is retrieving information on demand during exams. Educators, of course, refer to this as "cheating." They might better serve their students by redefining open-book testing as open-phone testing, for example, and by encouraging, rather than quashing, student innovation in this and other areas. Let me state definitively that I am not in favor of cheating. I *am* in favor of adjusting the rules of test-taking and other educational practices in a way that fosters student ingenuity and creativity in using learning tools and that supports learning rather than administration.

As these sorts of adjustments happen, new norms and ethics will have to emerge around technology in classrooms. But existing norms can change quickly when a new one is better. Some people can remember

how rapidly, in the 1970s, the norm went from "It's rude to have an answering machine" to "It's rude *not* to have an answering machine."

Educators should bear in mind that cell phones can be used for context as well as content (as in the aforementioned tour of Minute Man National Historical Park in Massachusetts). Those concerned that students use their tools not only to retrieve information but also to filter and understand it are the very people who should be figuring out how cell phones can meet this goal. Just as we are designing and refining Web- and PC-based tools for such tasks, so must we design similar tools for cell phones; the resulting communication and social features of the phones are likely to be of great help educationally.

Fully featured as cell phones are, it has been pointed out that they are not powerful enough to be students' *only* learning tool. This is, of course, true—and students will no doubt use whatever tools do the job, provided that they work well together. Cell phones can be our students' interface to a variety of computing devices, just as they control their entertainment devices. Even if future cell phone technology does not lend itself to every learning task, it will be suited to a wide range of tasks—and there is no reason not to take advantages of those capabilities.

Although I have tried to provide a variety of suggestions and examples of how cell phones might be used for learning, my goal here is not to present a complete vision, but rather to open the eyes of those who are ignoring an important resource for learning that is real and untapped today. I am convinced that once cell-phone-based learning is under way, the "world mind" of both educators and students will take it in a million useful and unexpected directions.

The Future

Cell phones are getting smaller and more powerful each day. The disposable cell phone is already patented and being manufactured; it is a mere two by three inches, with the thickness of three credit cards, and is made entirely of paper (the circuit board is printed with metallic conductive ink). Such phones, in volume, will likely cost less than a dollar each, with the air time for educational uses likely subsidized by carriers and others. Some already see mobile bills shrinking to only a few dollars as the mobile companies pay off their investments in the new networks (Stone 2004).

Although we often hear complaints from older Digital Immigrants about cell phones' limited screen and button size, it is precisely the combination of miniaturization, mobility, and power that grabs today's Digital Natives. They can visualize a small screen as a window to an infinite space and have quickly trained themselves to keyboard with their thumbs.

Despite what some may consider cell phones' limitations, our students are already inventing ways to use their phones to learn what *they* want to know. If educators are smart, we will figure out how to deliver *our* product in a way that fits into our students' digital lives—and their cell phones. Instead of wasting our energy fighting their preferred delivery system, we will be working to ensure that our students extract maximum understanding and benefit from the vast amounts of cell-phone-based learning of which they will, no doubt, soon take advantage.

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